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**Particle Analysis and Display  
System (PADS):  
Fog Monitor 100  
(FM 100) Module**

**Operator Manual**

**DOC-0181 Rev A-4**

**PADS 2.5.6**

**FM 100 Module 2.5.3**



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Consumable components, such as tubing, filters, pump diaphragms and Nafion humidifier are not covered by this warranty.

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## 1.0 Introduction

The Particle Analysis and Display System (PADS) is a software package that interfaces with instruments produced by Droplet Measurement Technologies (DMT) and other leading instruments used in the atmospheric sciences. This manual describes the PADS module for the Fog Monitor 100 (FM 100).

For an explanation of the basic PADS setup and instructions on how to acquire data using PADS, consult the *PADS Operator Manual*. Definitions and calculations used in the FM 100 module are also described in the *PADS Operator Manual*.

## 2.0 Configuration

Using PADS, you can configure both the software for the instrument and the instrument's data display in PADS. The following two sections explain how to do this.

### Configuring the FM 100

Your FM 100 and data system should arrive preconfigured from DMT. In some cases, however, you may want to change the software configuration for the instrument. To do this, follow the steps below. *Note: Droplet Measurement Technologies STRONGLY recommends that customers contact our office prior to changing any of the parameters in the instrument configuration. Improper changes can result in communication failure and/or changes in PADS computation algorithms, which can compromise data validity.*

1. Click on the “FM 100” tab.
2. From the **Configure** menu, select **Configure Instrument**. You will see the following window.

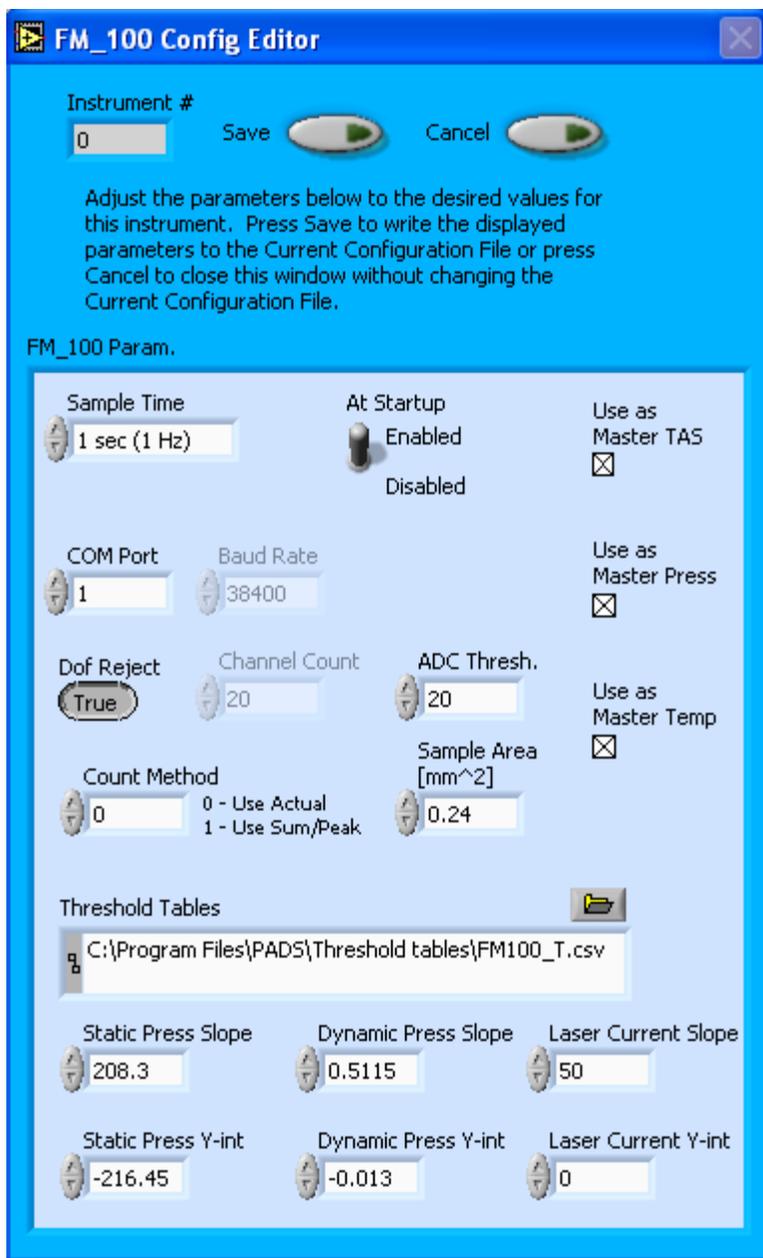


Figure 1: FM 100 Configuration Editor Window

3. Now you can configure the instrument parameters to your desired specifications. You will find a list of the parameters you may want to reconfigure in the two sections below, “Occasionally Reconfigured FM 100 Parameters” and “Rarely Reconfigured FM 100 Parameters.” If at any time you would like to revert to the previously saved values for the FM 100 parameters, press **Cancel** to exit the window without saving changes.
4. When you are done configuring the FM 100 parameters, press **Save** at the top of the Config editor window. (If you would instead like to revert to the previously saved values, click **Cancel**.) Then press the green **Reset Program** button for the new

configuration to take effect. Note that pressing the **Reset Program** button will clear any data currently being displayed.

### ***Occasionally Reconfigured FM 100 Parameters***

**Sample Time:** This parameter shows the time interval you'd like between samples. You can have the probe sample at intervals of .1, .2, .5, 1, 2, 5, or 10 seconds (10, 5, 2, 1, 0.5 or 0.1 Hz). A value of one is recommended, as described in the warning below. Note that if you increase the sample time, you will still collect data for the same number of particles. This is because the probe collects data continuously and relays cumulative data at each sampling interval. For example, say you have the sample time set to .5 seconds. You might see four particles of size 25  $\mu\text{m}$  during the first sample, and five particles of this size during the second sample. If you had set your sample time to one second instead of .5 seconds, you would instead get one sample that showed nine particles of size 25  $\mu\text{m}$ .

***WARNING: One hertz sampling is currently recommended, as choosing other values will invalidate time-dependent PADS calculations like number concentration, volume concentration, and LWC on optical probes. (ED and MVD are not affected.) This is a known bug in PADS that will be fixed in an upcoming version of the program.***

**At Startup Enabled / Disabled:** If you want the FM 100 to acquire data when PADS begins sampling, make sure this parameter is in the “Enabled” mode. In some cases, such as if the FM 100 is inoperative, you may want to use this control to disable the probe. Disabling the FM 100 allows data to transmit from other instruments without interference.

**COM Port:** This is the serial communications port that the FM 100 uses to connect with the computer. This number should match the computer hardware configuration for the particular computer you are using. If you are not using multiple computers, this number should not be changed.

You will notice that there are other parameters listed on the **FM 100 Config Editor** window. Most of these you should not need to change, and changing them inadvertently may compromise your data. If you are curious about these parameters or think you do need to modify them, see the section titled “Rarely Reconfigured FM 100 Parameters” below or consult with a DMT technical representative.

### ***Rarely Reconfigured FM 100 Parameters***

The FM 100 configuration editor displays several parameters that you will rarely need to modify. The following is a list of these parameters and an explanation of what they do.

**Instrument #:** This lists the number corresponding to the instrument you are viewing, in this case the FM 100. If your FM 100 has been assigned instrument number one, you will see “1” in this field. You should not need to modify the instrument number, and in fact you are unable to do so from within PADS.

**Baud Rate:** The Baud rate for the probe is defined at manufacture, and you should not need to change it. PADS lists this parameter because some probes can run at different baud rates. So if you reconfigure your hardware, the baud rate may change. In general, a higher baud rate means that the probe can transmit data more quickly to the computer. However, higher baud rates may not work with some computers and can result in unreliable data transmission.

**DOF Reject:** The DOF reject button tells the FM 100 whether to reject particles that fall outside the FM 100’s depth of field. The default value is true, and you should not need to change it. During probe calibration and alignment, DMT sets DOF Reject to false, so that the probe will report all particles it detects. (For a definition of Depth of Field, consult *Appendix A: Definitions* of the PADS Operator Manual.)

**Channel Count:** This number indicates how many sizing bins the FM 100 uses to categorize particles. This number has been grayed out because it is preconfigured for your instrument and should not change.

**ADC Threshold:** The ADC Threshold indicates the smallest peak digital value a particle can have and still be sized by the instrument. Small digital peaks can occasionally occur in the absence of particles, and the ADC Threshold can be used to eliminate such noise.

**Count Method:** This parameter is obsolete and you should not need to change it.

**Sample Area:** This is the physical area in which particles are detected. FM 100 sample area is a constant regardless of particle size. This value is preconfigured to match your instrument, so it is strongly suggested that you do not change it.

**Use as Master TAS:** When checked, this box tells PADS to use the FM 100's True Air Speed measurement as the TAS Source on the Setup window.

Several different instruments are capable of providing True Air Speed to PADS. If more than one such instrument is installed in your system, only one of them can be used as the global source for True Air Speed for calculations. When your system comes from DMT, one instrument will be selected as the Master TAS.

**Use as Master Press:** When checked, this box tells PADS to use the FM 100's static pressure measurement as the default master source for static pressure. This source appears on the PADS Setup window upon startup. While multiple instruments can potentially provide this measurement, only one instrument should be selected as the source.

**Use as Master Temp:** When checked, this box tells PADS to use the FM 100's ambient temperature measurement as the default master temperature source on the Setup window. While multiple instruments can potentially provide this measurement, only one instrument should be selected as the source.

**Threshold Tables:** This field lists the path to the threshold table files. These files are used in sizing particles, and the FM 100 has two threshold tables associated with it. (PADS only lists one of these tables in the Threshold Tables field, but both are in the directory.) `FM 100_t.csv` tells PADS the correct sizing bin for a particle given the peak digital value converted from the light scattered by the particle. `FM 100_p.csv` tells PADS the upper size boundary in microns for each sizing bin. Note that the Thresholds Tables field should always be set to the `FM 100_t.csv` file, and PADS finds the `FM 100_p.csv` file automatically using the same path.

**Static Press Slope:** This is the slope used in the linear function to derive static pressure from the voltage output of the static pressure transducer, as follows:

$$\text{Static Pressure} = (\text{Static Press Slope}) * (\text{Voltage}) + \text{Static Press Y-int}$$

Static Press Slope is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

**Static Press Y-int:** This is the intercept term used in the linear function to derive static pressure from the voltage output of the static pressure transducer, as follows:

$$\text{Static Pressure} = (\text{Static Press Slope}) * (\text{Voltage}) + \text{Static Press Y-int}$$

Static Press Y-int is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

**Dynamic Press Slope:** This is the slope used in the linear function to derive dynamic pressure from the voltage output of the dynamic pressure transducer, as follows:

$$\text{Dynamic Pressure} = (\text{Dynamic Press Slope}) * (\text{Voltage}) + \text{Dynamic Press Y-int}$$

Dynamic Press Slope is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

**Dynamic Press Y-int:** This is the intercept term used in the linear function to derive dynamic pressure from the voltage output of the dynamic pressure transducer, as follows:

$$\text{Dynamic Pressure} = (\text{Dynamic Press Slope}) * (\text{Voltage}) + \text{Dynamic Press Y-int}$$

Dynamic Press Y-int is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

**Laser Current Slope:** This is the laser current slope used in the linear function to determine laser current from a bit count, as follows:

$$\text{Laser Current} = (\text{Laser Current Slope}) * (\text{bits} + \text{Laser Current Y-int})$$

Note that this function differs from the traditional slope-intercept formula in that the intercept term is added before multiplication occurs.

Laser Current Slope is a conversion coefficient related to the electronics. Do not change this parameter without consulting DMT first.

**Laser Current Y-int:** This is the laser current intercept used in the linear function to determine laser current from a bit count, as follows:

$$\text{Laser Current} = (\text{Laser Current Slope}) * (\text{bits} + \text{Laser Current Y-int})$$

Note that this function differs from the traditional slope-intercept formula in that the intercept term is added before multiplication occurs.

Laser Current Y-int is a conversion coefficient related to the electronics. Do not change this parameter without consulting DMT first.

After making changes in the instrument configuration window, you will need to press the **Save** button and then click the green **Reset Program** to activate these changes. Clicking **Reset Program** will clear any data PADS is currently displaying.

## Configuring the FM 100 Display

To configure the FM 100 display, go to the **Configure** menu from the FM 100 tab and select **Configure Display**. This will bring up the following window.

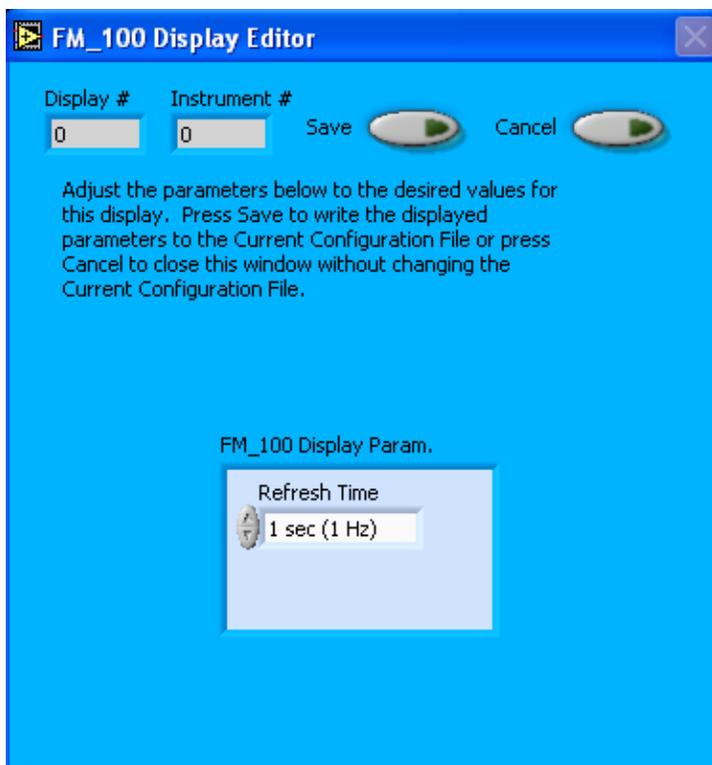


Figure 2: FM 100 Display Editor Window

You do not need to modify the **Display #** or **Instrument #**. Changing the **Refresh Time** allows you to set the time intervals for data display during acquisition mode; you can choose any time that is equal to or greater than the sample time. (Choosing a time less than the sample time is not useful, since the same data will be displayed multiple times.)

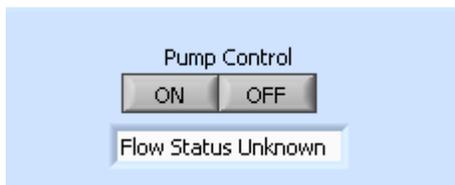
When you are done, click on **Save** to update the configurations or **Cancel** to revert to the previous configuration. After you reset PADS, you will be able to see any changes you have made to Refresh Time. Note that clicking **Reset Program** will clear out any data currently being displayed.

### 3.0 The FM 100 Window

The following sections describe the different sections of the FM 100 Window: the channel tab, the chart displays, and the histogram display.

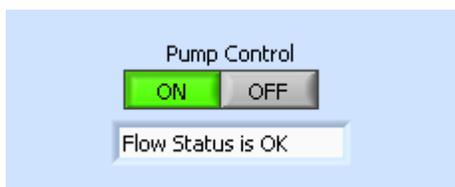
For explanations of the **Enable** button, **COM Port** indicator, and **Fault/No Fault** button, see the “Instrument Tabs” section of the *PADS Operator Manual*.

Just above the FM\_100 Data window, you will see the pump control and flow indicator, as shown in Figure 3.



*Figure 3: Pump Control and Flow Status Indicator at PADS Start-up*

The pump control indicates whether the FM 100's pump is on or off. When you first open PADS, the control will not indicate the pump's status. Instead, both buttons will be gray, as in Figure 3. (The pump itself may be either on or off, depending on how it was last set.) Once you instruct the pump to turn on or off using the buttons, however, they will reflect the pump's status until the time you close PADS. For instance, if you press "ON," the display should appear similar to that in Fig. 4.



*Figure 4: Pump Control and Flow Status Indicator when Pump is Operating*

The flow status indicator has three possible values: Flow Status Unknown, Flow Status is Okay, and Flow Status is Low. "Flow Status Unknown" indicates that the program is not currently acquiring data from the probe, and hence the value of the flow cannot be known. "Flow Status is Okay" indicates that the program is acquiring data and that the pump is generating a flow of at least 5 m/sec. "Flow Status is Low" indicates that the probe is on, but the pump is generating a flow of under 5 m/sec, indicating a possible problem with the pump, flow path, or flow sensor.

The TAS (m/s) field on the FM\_100 data screen shows the current flow reading. Note that TAS is really the probe airspeed, which in this case is the airspeed of the air going through the pump. A pitot tube measures this flow.

## Channel Tab

The FM 100 data tab is shown in Figure 5.

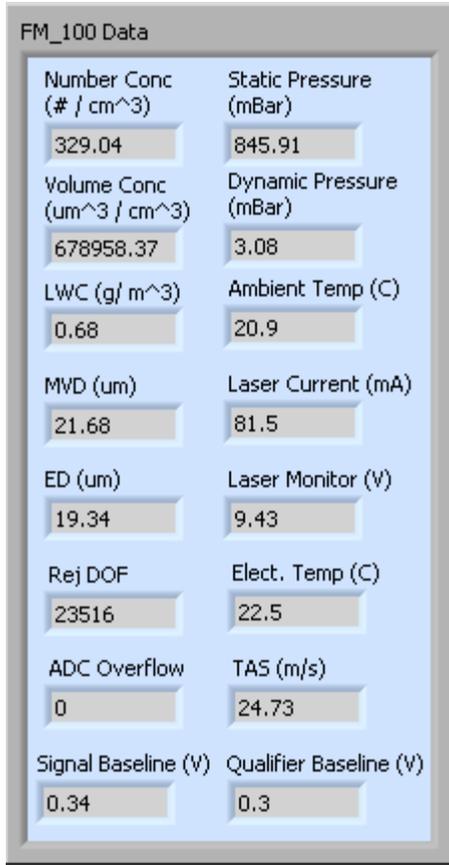


Figure 5: FM 100 Channel Data

For information on specific channels, their definitions, and their acceptable ranges, consult *Appendix A: FM 100 Channels* and the PADS Operator Manual’s *Appendix A: Definitions*.

## Chart Displays

The FM 100 time-series charts appear in the top half of the FM 100 tab. PADS organizes the displays using four tabs. You can access the charts by selecting these tabs, which are shown in Figure 6.

Once you are viewing the chart you want to see, you can zoom in on the data using the time controls.

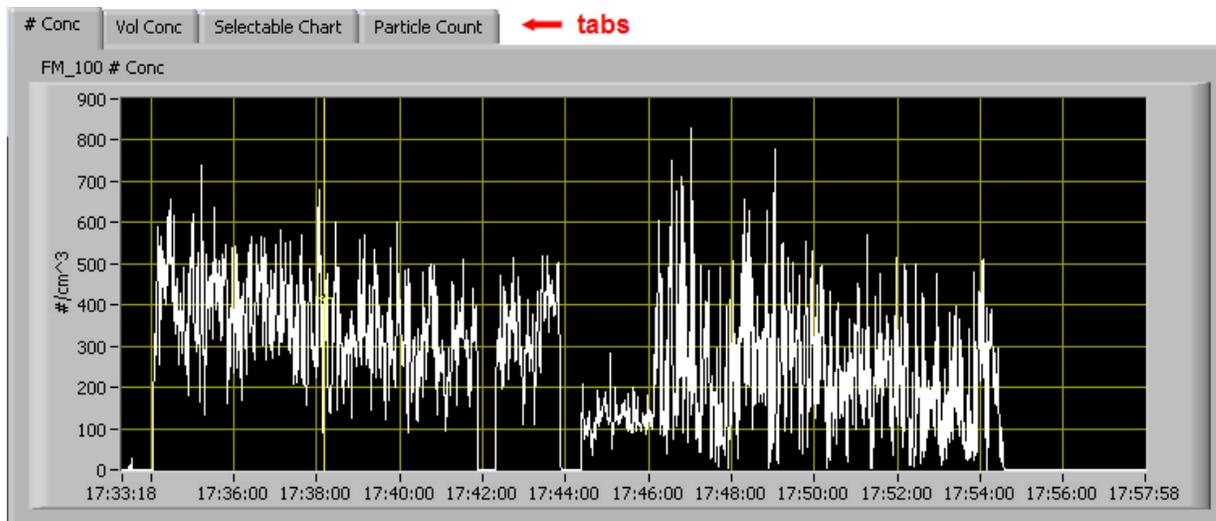


Figure 6: FM 100 Chart Tabs

When you access time-series charts in playback mode, the currently selected moment in time is indicated by a yellow cursor, as shown above. The y-axis value for this time is indicated by cross (+) on this cursor. Note that when you display a large range of time-series data, the chart display does not have sufficient resolution to display each individual time point. To increase resolution, zoom in on the data by changing the time interval to a smaller range.

On all the charts with x and y axes, you can change the scale by typing a different number into the starting and ending values on each axis. For instance, if you want to change the time period in one of the graphs above to end at 17:45:00, you simply select the field that currently says 17:57:58, type in 17:45:00, and hit the <Enter> key. In acquisition mode, you must disable autoscaling (see below) before you modify fields in this way.

Many charts also show you options for scaling and copying the data when you right-click on them. These options are as follows:

**Autoscale** This autoscales the relevant axis. In autoscaling mode, the minimum and maximum values of the axis are set automatically so that all data points can be seen in the display. Note that on charts that have autoscale buttons, like the large histogram chart on some instrument tabs, the buttons override the Autoscale options in the drop-down menu. To see autoscaling options in the drop-down menu, position the cursor over the relevant axis before right-clicking. Note that you may not always be able to autoscale the x-axis.

**Copy Data** This copies the chart to the clipboard using a screen capture. This chart can then be pasted into other documents like Word or PowerPoint presentations.

**Export Simplified Image** This copies a simplified image of the data to the clipboard or an output file. You can choose the format you desire—bitmap (.bmp), encapsulated postscript (.eps), or enhanced metafile (.emf). Note that when you select the .eps option, you must copy the data to a file. Unless you specify otherwise, output files will be saved in the time-and-date-specific output file directory for the current session.

**Clear Graph** This erases the currently displayed data points from the graph.

More information about each of the tabs on the chart displays section is given below.

### **1. # Conc**

The first tab plots the number concentration ( $\#/cm^3$ ) with respect to time. In playback mode, you can zoom in or out by using the time controls.

### **2. Vol Conc**

This tab plots volume concentration ( $\mu m^3/cm^3$ ) with respect to time. In playback mode, you can zoom in or out by using the time controls.

### **3. Selectable Chart**

This tab allows you to display two selectable charts overlaid on each other. You can select which FM 100 channels you'd like to display using the controls in the upper left and upper right of the window. You can either use the arrow buttons to move up and down between options, or you can see the entire list of available channels by clicking on the white field, which will bring up a drop-down menu. The legend for the graphs is displayed in the upper center of the window, as shown in Figure 7. In this figure, both LWC and ED are plotted with respect to time.

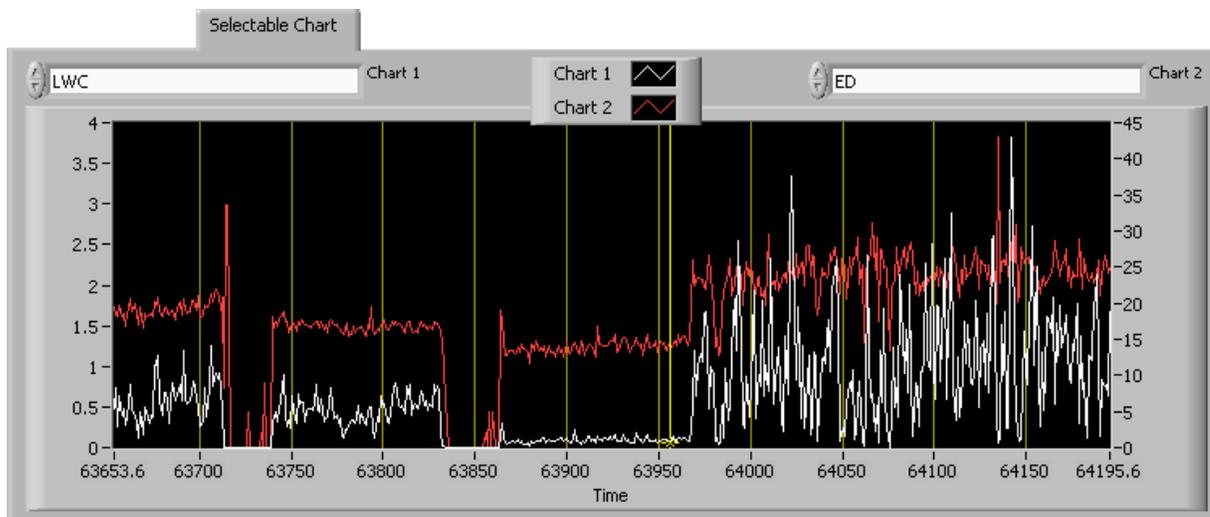


Figure 7: Selectable Charts Tab

#### 4. Particle Count Tab

The last tab displays a total particle count plotted with respect to time.

### Histogram Data Window

On the bottom of the instrument window is the histogram display of acquired particle data, as shown in Figure 8. Like the channel tab display, the histogram shows time-specific data. The x-axis labels indicate the upper boundary of each size bin, which PADS reads from the `FM 100_p.csv` threshold table. A bin's lower boundary is the upper boundary of the previous bin, except for the first bin, which has a lower boundary of 2  $\mu\text{m}$ . *Note: This size limit may not exactly match the actual size of the smallest particles in bin 1, which is determined by your ADC Threshold setting. However, the discrepancy is minor and does not significantly affect calculations such as concentration, ED, LWC, and MVD.*

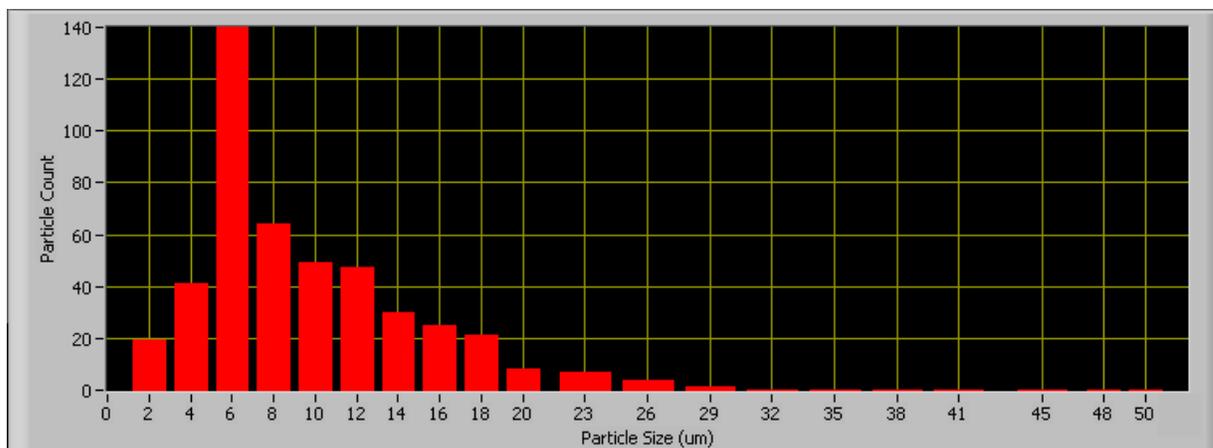


Figure 8: FM 100 Histogram Window

At the bottom left of the FM 100 screen are three buttons that you can use to manipulate the histogram display:

### Autoscale Button

The Autoscale Y control lets you control how the y scale is set. If you enable autoscaling, PADS will automatically select an appropriate scale with which to display the current data. For instance, if the probe is not currently detecting many particles, the y-axis range will decrease. On the other hand, if you disable autoscaling, the scale of the axis will remain constant. In this case, the range will always be the same as it was when autoscaling was disabled. The minimum and maximum Y values can then be changed manually by typing new numbers into these fields. *In playback mode, autoscaling will not take effect until you change the time using the time controls.*

Note that the Autoscale Y button overrides the Autoscale Y option in the drop-down menu that appears when you right-click on the chart.

### Log-Scale Button

When you turn on the Log-Scale button, PADS scales the y-axis logarithmically rather than linearly. Autoscaling can be enabled or disabled with this option.

### Normalized Button

If you enable normalization, PADS will scale the particle data so that each bin of data is divided by the width of that bin in  $\mu\text{m}$ . Normalization is useful when the widths of the size bins are not constant, as is often the case when an optical spectrometer has to cover a large size range or if some size bins are made larger to decrease uncertainty due to

operational limitations. Without normalization, the concentrations from one size bin cannot be compared quantitatively from those in another size bin of different width. For example, if 8 particles are counted in a size bin that is 2  $\mu\text{m}$  wide and 8 particles are counted in the next larger channel that is 4  $\mu\text{m}$  wide, the size distribution would appear flat and we would assume that it was equally probable to measure particles of either size. This is a biased sample, however, since the larger size bin is twice as large as the smaller. If we normalize by the width, however, we find that the smaller size category has 4 particles per  $\mu\text{m}$  and the larger size bin only has 2 particles per  $\mu\text{m}$ . This is now an unbiased sample.

## Appendix A: FM 100 Channels

A list of FM 100 channels appears below. The FM 100 output file will contain data values for each channel for each sampling instance. You can also plot each of these channels as a function of time using the FM 100 Selectable Charts tab.

For definitions of the channels, consult *Appendix A: Definitions* in the *PADS Operator Manual*.

Time	FM_100_OPC_ch10
Signal_Baseline (V)	FM_100_OPC_ch11
Masked_Baseline (V)	FM_100_OPC_ch12
Ambient_Temp (C)	FM_100_OPC_ch13
Laser_Current (mA)	FM_100_OPC_ch14
Optic_Block_Temp (C)	FM_100_OPC_ch15
Static_Pressure (mBar)	FM_100_OPC_ch16
Dynamic_Pressure (mBar)	FM_100_OPC_ch17
Electronics_Temp (C)	FM_100_OPC_ch18
Rej_DOF	FM_100_OPC_ch19
ADC_Overflow	Number_Conc
FM_100_OPC_ch0	Volume_Conc
FM_100_OPC_ch1	LWC
FM_100_OPC_ch2	MVD
FM_100_OPC_ch3	ED
FM_100_OPC_ch4	Calculated TAS
FM_100_OPC_ch5	Global TAS
FM_100_OPC_ch6	Global Pressure
FM_100_OPC_ch7	Global Ambient Temp
FM_100_OPC_ch8	Status
FM_100_OPC_ch9	GPS Time

FM 100 channels fall into several broad categories:

**Time Channels:** The time channels store time data. Time is generated by the PADS computer clock and is the time when the program receives the FM 100 data. It is given in seconds after midnight on the day the program was started. GPS Time is included in every instrument's list of channels whenever a GPS is included as one of the PADS instruments. GPS Time may be collected from an instrument other than the FM 100, even though it appears as a channel in the FM 100 output file.

*Housekeeping Channels:* The FM 100 has 8 A/D housekeeping channels that have a 0-20 V range measured by a 12-bit A/D converter that gives integer values from 0 to 4095. Several of the housekeeping channels store data that indicate whether the probe is functioning properly. A list of these housekeeping channels is given below.

<i>Signal_Baseline (V)</i>	<i>Optic_Block_Temp (C)</i>
<i>Masked_Baseline (V)</i>	<i>Static_Pressure (mBar)</i>
<i>Ambient_Temp (C)</i>	<i>Dynamic_Pressure (mBar)</i>
<i>Laser_Current (mA)</i>	<i>Electronics_Temp (C)</i>

*Bin Channels:* Channels labeled FM\_100\_OPC\_ch[i] store data on the number of particles of different sizes that the FM 100 has detected. These data are used in the histogram display.

*Channels for Other Statistical Data:* Reject\_DOF and ADC\_overflow store particle statistics collected by the FM 100. Status stores statistical data the FM 100 has gathered on the communication between PADS and the probe.

*FM 100 Calculated Channels:* Number\_Conc, Volume\_Conc, LWC, MVD, and ED store the results of calculations PADS has performed on FM 100 particle data. Calculated TAS stores the true air speed collected by the master TAS source designated on the PADS Setup screen.

*Global Channels:* Global TAS, Global Pressure, and Global Ambient Temp store global data collected by the master source instruments designated on the Setup screen.